

1 gas-metal system, is defined as the change in Gibbs Free Energy, in Joules per mol,
2 that would be required to force one more mol of a gas into a large gas/metal system,
3 at its present free energy state, while holding the temperature, pressure and the
4 concentration of other species constant. The chemical potential, μ , of the deuterium
5 gas is given by the equation:

$$\mu = (0.5RT)\text{Log}_n(P/P_0) \quad (\text{Equation 1})$$

7 where: μ is the gas chemical potential (J/mol), R is the gas constant (8.32
8 Joules/mol°K), T is the temperature in Kelvin, P is the deuterium gas pressure in
9 atmospheres and P_0 is the selected standard state pressure of 1 atmosphere. Since
10 the chemical potential of the dissolved deuterium is a function of the D gas chemical
11 potential, it is also a function of the two control variables, T and P .

13 **Host metal selection:**

15 The threshold deuterium gas chemical potential may vary from one candidate
16 host material lot to another. The threshold D chemical potential for a specific host
17 metal is also dependent on the system's electronic Fermi energy as well as other
18 factors including the purity, crystal size and regularity, and the population of flaws,
19 cracks, vacancies, distortions and dislocations in the crystal lattice structure of a
20 particular host material. Some of these micro-properties might be altered in the
21 process of installing the host inside of the reactor.

22 Because of this variation in micro-properties, each lot of the candidate metals is
23 subjected to screening tests, in their final form, to determine their threshold deuterium
24 gas chemical potentials. Such screening tests are conducted for any candidate host
25 metal in a properly instrumented pressure vessel. The material-form combinations
26 with the lowest threshold chemical potentials are the best candidates. The final
27 selection of a metal/form will be dictated by the application requirements.

28 The 'instrumented' pressure vessel for screening the candidate host materials
29 is called a 'scanning' reactor with means for temperature and deuterium gas pressure
30 control. For the scanning reactor to be an effective tool for the process of selecting the
31 host metal and form, it is designed for a broad operating range in terms of high D
32 chemical potentials, high temperatures and high pressures. When the reactor body is
33 made from pure tungsten, D chemical potentials up to the range of 70 kJ/mol,

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